Portable Mass Spectrometer Applications for in situ Environmental Gas Monitoring

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Collaboration

NASA/KSC

- ISS
- Human Exploration
- Robotic Exploration
- Earth Science

CENET/Costa Rica

- Volcanic Emission
- Volcanic Activity
- City Air Quality
- Pollution Levels

Purpose of Project

Primary Goal:

- Design/build a flexible system to monitor air contamination
- Learn requirements for operating system in low pressure and low temperature environments
- Design/build system for integration into aircraft and automobiles

Secondary Goals/Offshoots:

- Fly aboard different aircraft
- Hand-carry unit
- Drive unit in automobiles

Current Sampling Techniques

Technique	Benefits	Shortcomings
Infrared (IR) Spectroscopy	- Irrefutable Identification in Simple System - Good Detection Limits (mid-ppb) - Good Quantitation	- Water is Interfering - Optics not Rugged - Poor for Complex Mixtures
Electrochemical Detection	- Capable of High or Low Specificity - Generally Inexpensive - Small, Lightweight, Power Efficient - Excellent Quantitation - Good Detection Limits (mid-ppb)	- Poor response to noble gases - Mediocre Response Time
Mass Spectrometry (MS)	- Highest Specificity - Excellent Identification - Good Quantitation - Reasonable Detection Limits (upper-ppb) - Rapid Response & Analysis Time	- Weight & Size Issue - Power Efficiency Issue
Sample Bottle	-Simple, No Complex Instruments at Site -Ease of Use -Light Weight	-No Real-time Analyses -Degradation of Sample -Difficult to Map Region -Unknown if Issue With Sample

Design Considerations

Short Timeline of the Project (< 6 months)

Use of Proven Technologies

- Linear Quadrupole
- Proven Flow Design
- Valves/Fittings/Flow controllers

Allowed New Work in Specific Areas

- New Architecture
- New Automated Operation
- New Data Archiving/Retrieval
- Use in New Environments

AVEMS Specifications

	H_2 (2 Th)	Helium (4 Th)	O_2 (32 Th)	Argon (40 Th)	CO_2 (44 Th)	Acetone (43 Th)	SO_2 (64 Th)
Accuracy (%)	32.0	1.6	4.5	1.7	8.8	4.9	2.1
Precision (%)	3.9	5.7	2.9	3.3	1.7	1.2	1.3
LOD (ppm)	13.1	1.3	225	1.0	12.4	3.7	1.1
2-hr Drift (ppm)	472*	3.4	–	11	160*	3	1
Response (s)	7	5	6	5	7	–	8
Recovery Time (s)	7	3	–	4	8	–	8

Monitored Volcanoes

- Flew unit over and around volcanoes
- Drove unit to volcanoes
- Map volcanic plume
- Issues with GPS resolution on ground data

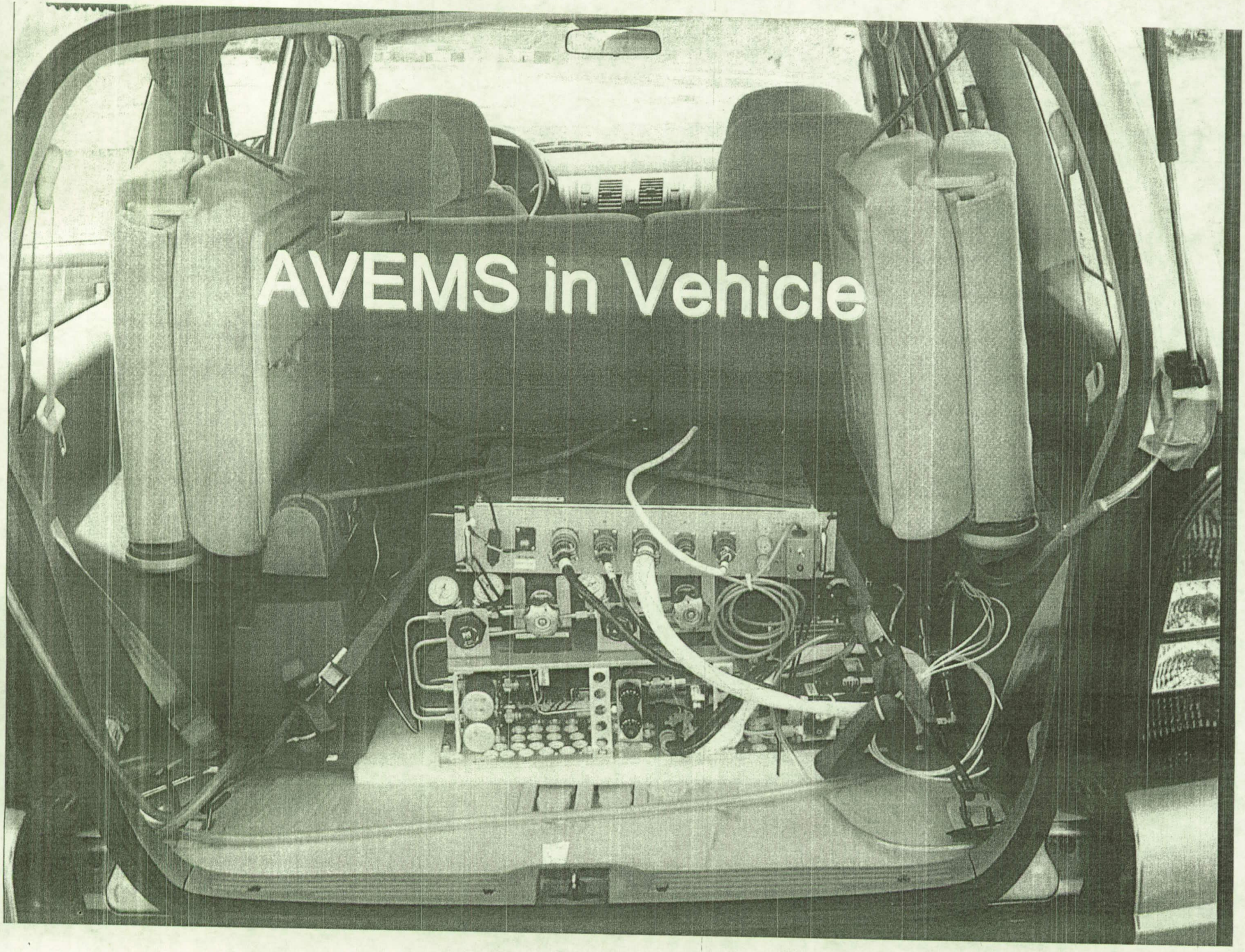
Drove Unit Around San Jose, Costa Rica

Reason for San Jose

- 2/3 of people live in San Jose Area ??
- No smog control on vehicles
- Large bus/semi traffic
- Manufacturing area

Areas of Concern

- Hospitals
- Schools
- Parks
- City Center


AVEMS in Vehicle

Conclusions

- Unit successfully monitored air quality around city regions
- Unit very versatile: fly, hand-carry, drive
- Large areas of pollution around important areas in city
- Main reason for pollution in downtown primarily from vehicles
- Can use the data, GPS and concentration to map location of major pollution

Future Work

- Use new/improved mass analyzer
- Use smaller/lighter valves/controllers
- Improve autonomous operation
- Investigate pre-concentration techniques
- Incorporate an improved GPS

Acknowledgements

- Thank CENET and NASA/KSC for funding for this project

- Thanks to others on the project

Costa Rica Team Members